International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 24 Issue 4 – MARCH 2017.

DESIGN AND DEVELOPMENT OF PNEUMATIC ARTICULATED ROBOT FOR PALLETIZING OPERATIONS

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***Abstract*— Pick and Place Robot can pick the objects on the conveyor belt based on Optical sensor and metal detecting sensor and placing it in a specific location. It will be using a picking arm which uses a pneumatic cylinder to pick the particular object from the conveyor belt and place it according to the metal and non-metal conveyor. The end effector can be considered the most important component of the robot which deals with various sources like manufacturing products, horticulture products, etc. The designed adaptive gripper can perform easier and faster picking and placing operation for multiple shapes and size objects. Pick and place robotic automation speeds up the process of picking parts up and placing them in new locations, increasing production rates. With many end-of-arm-tooling options available, pick and place robots can be customized to fit specific production requirements. Moving large, small, heavy, or hard-to-handle products can be an easy task to automate in the factory line. Consistency is also a benefit of using a pick and place system. The robots can be easily programmed and tooled to provide multiple applications if required.**

***Index Terms*— Optical sensor, Metal Detecting Sensor, PL
Pneumatic Cylinders, Robotic Arm.**

I. INTRODUCTION

Robotics is the branch of engineering science Technology related to robots, and their design, manufactur application, and structural disposition. Robotics is related electronics, mechanics, and software. Robotics research toda is focused on developing systems that exhibit modularit flexibility, redundancy, fault-tolerance, a general ar extensible software environment and seamless connectivity other machines, some researchers focus on complete automating a manufacturing process or a task, by providin sensor based intelligence to the robot arm, while others try solidify the analytical foundations on which many of the basic concepts in robotics are built.

In this highly developing society time and man power are critical constrains for completion of task in large scales. The automation is playing important role to save human efforts in most of the regular and frequently carried works. One of the major and most commonly performed works is picking and placing of jobs from source to destination.

A. Figures

1) DESIGN CONSIDERATION:

For designing Laws of Robotics and the Jointed Arm robot some important considerations are done in system specification, system performance and configuration and in design of different components of the robot. In system specification, robot reach, load capacity, work envelope and range is considered. Its drive configuration, joint travel range, number of degrees of freedom is considered in its configuration. For its performance system velocity, accuracy, precision, repeatability and component life are taken into its considerations. Detailed design of robot structures and joints, actuators, its transmission and wiring and routing of cables and hoses is done. This design is considered from the laws of robotics [2].

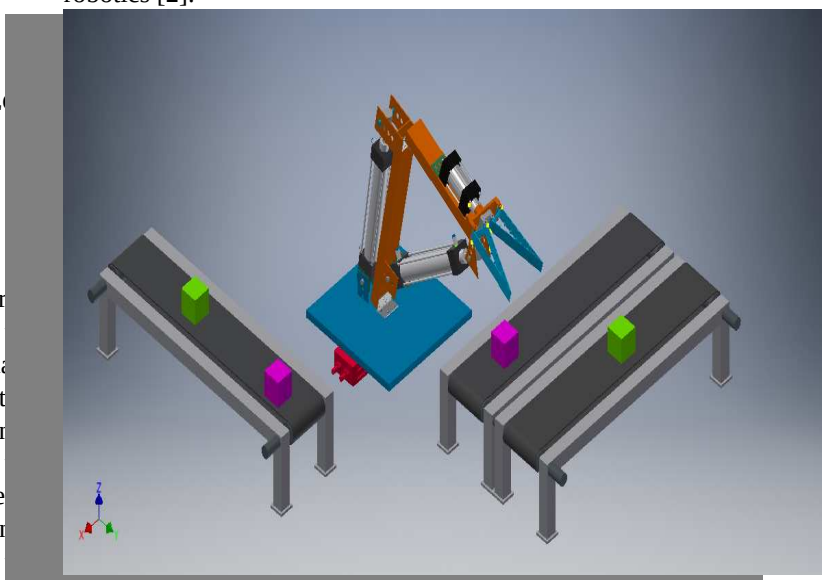

Fig.1 Project design using Autodesk Inventor professional

B. Selection of Linear displacement cylinders [5].

1) For Shoulder

Stroke length = 75mm, diameter of the piston = 32mm.

Load =10 kg or 10*9.81 = 98.1N

Pressure = Load/Area
= L/ (pi*d²/4)
= 98.1/ (3.147*0.032²/4)= 1.22 bar

Since the available standard cylinder, diameter 32 mm and stroke length 75mm, the cylinder used for shoulder are selected with the dimensions of 32mm x 75mm.

2). FOR ARM

S = 150mm
Load = 8kg or 8*9.81 = 78.48N
Pressure = Load/Area
= L/ (pi*d²/4)
= 78.48/ (3.147*0.040²/4)
= 0.6 bar

Since the available standard cylinder, diameter 16 mm and stroke length 150mm, the cylinder used for arm are selected with the dimension of 16mm x 150mm.

C. Degree of Freedom [5]

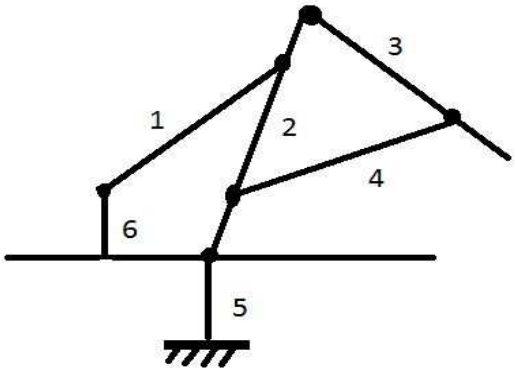

Fig.2 Links and Joints 2D diagram

Number of links,l = 6
Number of joints,j =6
Number of higher pair,h =0
Number of degree of freedom = 3(n-1)-2j-h
= 3(6-1)-2*6-0
Degree of Freedom = 3

D. DESIGN OF THE SYSTEM:

The proposed system is an integration of Electro Pneumatic system and PLC. PLC is the main controller which will accept the inputs from optical sensor and metal detecting sensor Accordingly the PLC will control the pneumatic robot. In addition the system is controlled via Control panel. The system can be controlled in auto mode as well as in Manual mode.

This robot consists of pneumatic actuators link together with the help of an mechanical frame controlled through PLC via Solenoid valves. The pressurized air is supplied through air compressor which is further regulated and filtered using Air Filter and Regulator (AFR) unit [1].

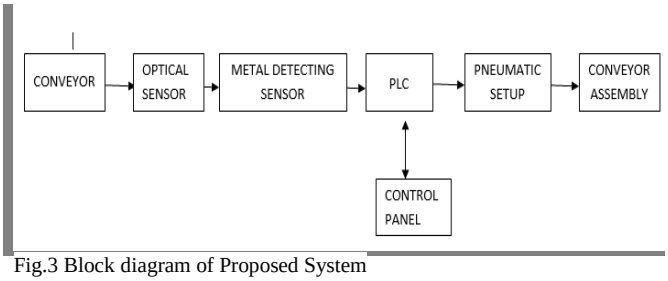

Fig.3 Block diagram of Proposed System

II. DESIGN OF RELIABLE MECHANICAL JOINTS:

The function of a joint is to permit relative motion between two links or arms of a robot. It provides controlled relative motion between two links (Input and Output).Generally one joint provides the robot with one degree of freedom. There are various joint such as linear joints, orthogonal joints, rotational joints, twisting joints, and revolving joints. Of the given joints the rotational is easiest to manufacture and is best suited for our assembly line. Thus the rotational joints are used. The cost of rotational joint is very less and can best satisfy our requirement. However based on the strength and weight to be lifted, various types and quality of rotational is used [2]

III. DESIGN ASPECT OF LADDER DIAGRAM LOGIC

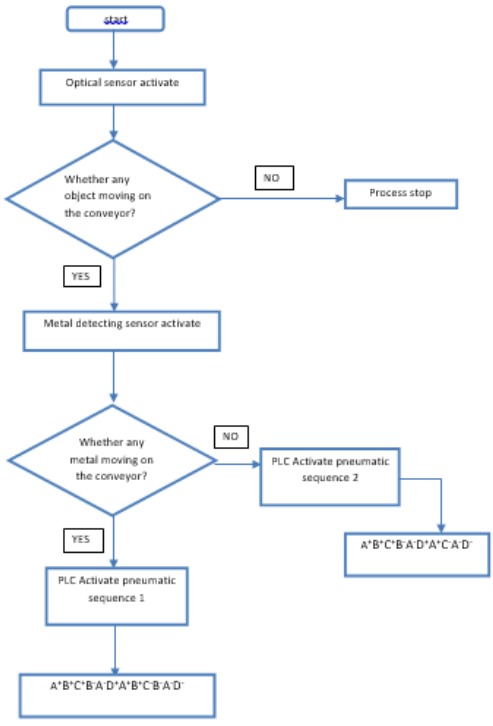

Fig.4 Design of Ladder diagram

- A, B, C, D are the pneumatic cylinders.
- A, B, C are the linear actuator and D is the rotary actuator.
- A indicate shoulder cylinder, B indicate arm cylinder, C indicate gripper cylinder, D indicate base cylinder (for rotary motion up to 900).

IV. MATERIAL SELECTION

The most suitable material to fabricate the structure of the

arm has to be light and strong. Among the materials that can be considered to fabricate the structure are Mild steel, and PVC Gripper. In choosing the fabrication materials, the aspect of availability of the materials, the overall cost and the flexibility to be shaped, should also be taken into consideration. Thus among the three materials considered, mild steel is the most ideal material to be chosen as fabrication Material [3].

V. DRIVE SYSTEM

The drive chosen based on

- The power consumption
- Repeatability
- Positional accuracy
- Stability
- Speed of operation
- Reliability
- Cost

Out of Hydraulic, electrical and pneumatic; Pneumatic drive make use of compressed air which is readily available and non-flammable. Pneumatic drives are of lighter construction [4].

Advantages of using Pneumatic drive

- Freely available from atmosphere
- Easily transportable in vessel and pipes
- Clean system. It has self-cleaning properties.
- The pressure, speed and forces can be controlled easily.
- Low cost of maintenance

VI. COMPONENTS USED

A. PNEUMATIC SYSTEM
- a. Air compressor
- b. Air filter and regulator unit with indicator gauge
- c. Direction control valve
- d. Solenoid valves
- e. Pneumatic actuators
  - 1) Linear actuator
  - 2) Rotary actuator
- f. Pneumatic connectors
- g. Limit switches
- h. Pneumatic piping
- If. Pneumatic Gripper

B. Robotic Arms
C. Metal Detecting Sensor
D. PLC
E. Conveyor

SOFTWARE COMPONENTS:
A. Codey's Software
B. Fluidsim (P) V5.0
C. Autodesk Inventor Professional-2016

VII. SELECTION PARAMETER FOR PNEUMATIC ACTUATORS

The parameters to be considered during the selection a Pneumatic Actuator are as follow:

1. Desired Position Timing: It is desired to be in the range of 1 sec to 3 sec.
2. Stroke Length: It is the length of the shaft which actuates as pressure is applied.
3. Alignment Angle: It is the angular position of the Pneumatic Actuator.
4. Direction of Movement: It is the direction in which the actuation occurs.
   - a. Extended.
   - b. Retracted.
5. Air Supply Pressure: According to International Slandered the intrinsically safe range for operation of a pneumatic cylinder in general purpose application is 3 Bar to 15 Bar.
6. Tubing Length: The length of the tube is an important factor as pneumatic losses may increase as tubing length increases. The following are the

Locations where pneumatic piping length is considered.

a. Air Supply to Valve.
b. Valve to Pneumatic Actuator.

7. Load Setting: Various kinds of loads on the pneumatic actuators are considered.

These are as follows:
- a. Moving Mass.
- b. Additional Thrust.
- c. Additional Friction.

VIII. CONCLUSION

This robot involves sorting of objects through metal sensors, the future advancements can be done by increasing the efficiency of the metal sensor. This method is verified to be highly beneficial for automated industries. The sensor is key component of project which aids in distinguishing objects. Thus it become vital that the sensor had a very high sense of sensitivity and ability to distinguish between metals and non-metals.

ACKNOWLEDGMENT

This Work was Supported by the Staff Support and Facilities Provided by the Department of Mechanical Engineering, Ramco Institute of Technology, Rajapalayam, India.

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